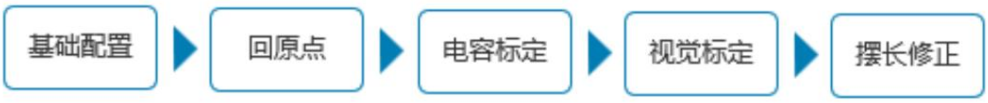
I. Preliminary Debugging

The initial debugging is used for the first power-on debugging after the mechanical assembly is completed. It aims to ensure that returning to the origin and jogging of each motion axis can be achieved normally, and to correct the model errors caused by the mechanical assembly.

1.1 Debugging Process

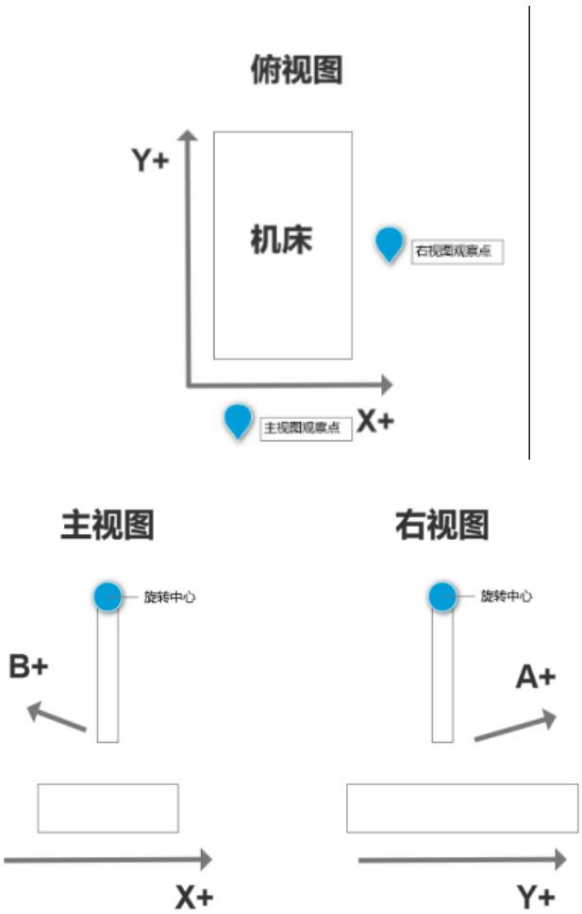


1.2 Debugging Steps

1.2.1 Basic Configuration

Before opening the FACut software, you should first configure the basic parameters of the height controller and the machine tool's X/Y/A/B/Z axes in the platform configuration tool.

Parameters such as travel range can be roughly set to a value first; pulse equivalent, limit logic, origin switch logic, servo alarm logic, return to origin direction, and return to origin sampling signal should be filled in according to the actual situation to achieve the effect shown below.

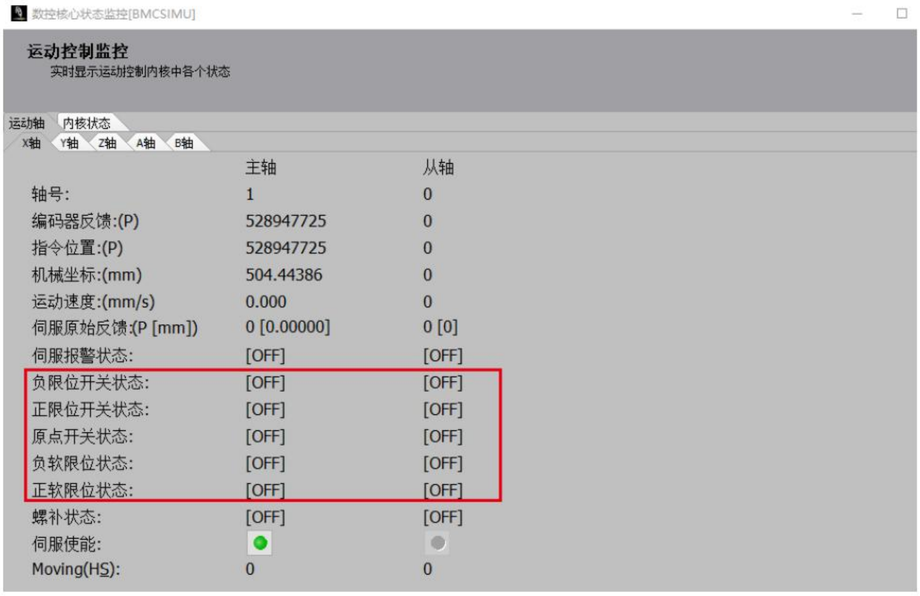


1.2.2nd time, origin

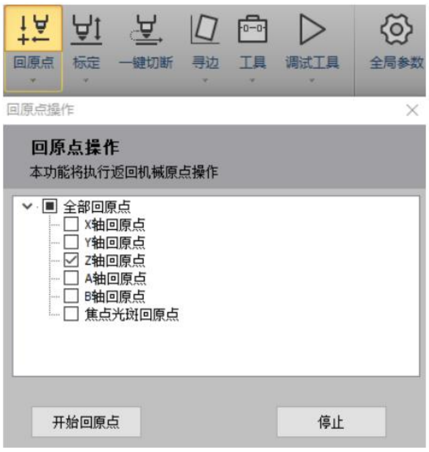
Open the FACut software.

Slowly jog each axis (the jog speed of each axis can be set in the "Parameter Settings" page of the machining control bar). If there is a soft limit alarm, you can disable soft limit protection in the parameter settings options; if there is a homing alarm, you can use the "Ignore Homing Alarm" option in the drop-down button of "Homing".

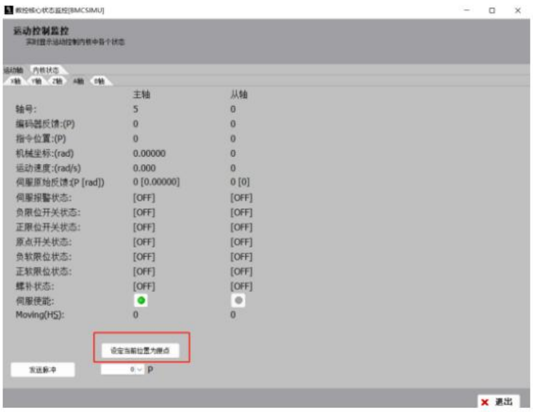
After confirming that the jogging is working correctly, open the "Motion Control Kernel Real-time Monitoring" in the "Tools" menu, and trigger the origin and limit switches of each axis in sequence (do not jog the axes; if the limit switches are photoelectric switches, use a baffle to block the photoelectric gate), and observe whether there are corresponding signals on the monitoring interface.



After verifying that the origin and limit switches are correct, you can proceed with the return-to-origin operation. For the first debugging session, please perform a single-axis return-to-origin test first. Click the <Return to Origin> button, and in the pop-up window, perform single-axis return-to-origin operations for the Z/X/Y axes sequentially.

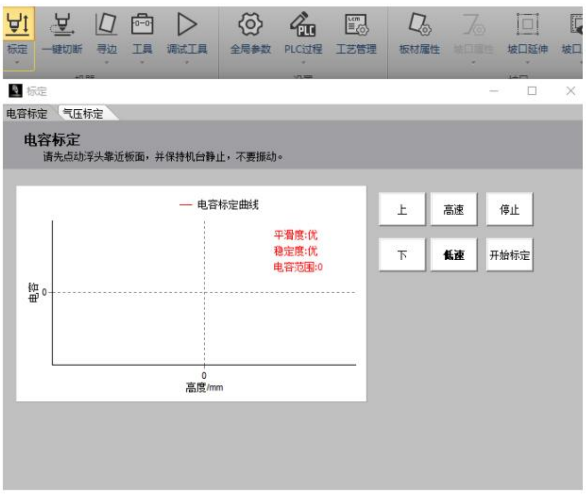


For the AB axis, if it is a relative encoder, ensure that it successfully returns to the origin; if it is an absolute encoder, jog the AB axis to a roughly vertical position (as shown in the figure), then execute <Set Current Position as Origin> (Tools - Motion Control Kernel Real-time Monitoring, as shown in the figure), and then click Upward Vertical.



1.2.3 Capacitor Calibration

With the Z-axis returning to the origin, enter the capacitance calibration module. Jog each axis to bring the cutting head close to the horizontal plate surface to complete the capacitance calibration. The calibration results should have both smoothness and stability rated as "excellent".

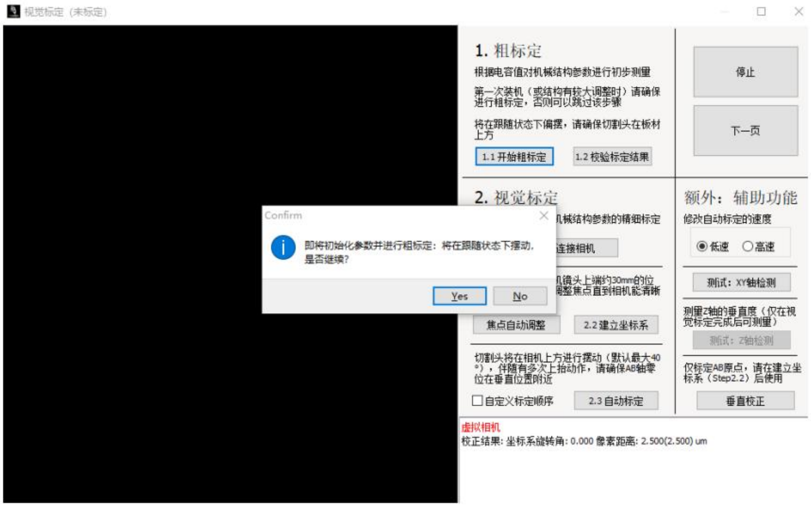


1.2.4 Visual calibration

1) Coarse calibration

Coarse calibration should be performed when installing a new machine or when the swing arm structure is changed; otherwise, this step can be skipped. Open the Tools - Visual Calibration interface.

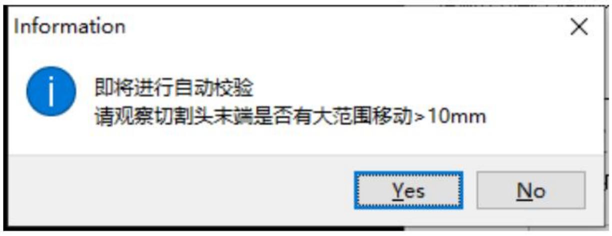
Ensure there is a plate below the cutting head to follow, and click <Start Coarse Calibration> on this interface. This action will cause the cutting head to swing around the plate surface in the following state (the angle between the swing head and the plate surface is the <swing angle>), finally returning to a vertical position. During the swing, the swing may pause, waiting for the following error to be less than the <allowable following error> before resuming.



Note: The position of the cutting head will change during the movement, so please ensure that there is a large enough area to follow it.

Select a board material larger than 300mm x 300mm, and click [Start Coarse Calibration] at the center of the board. During this process , the single-axis speed is limited to a very low level. Stop the process as soon as you see signs of board ejection, as shown in the figure.

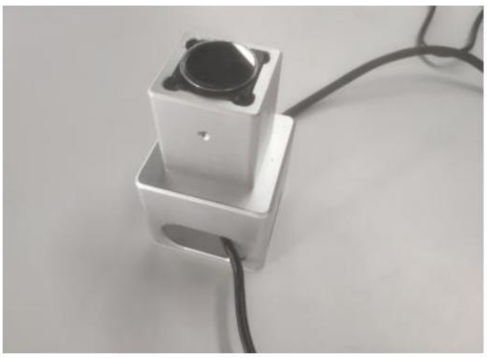
After the coarse calibration is completed, the calibration results need to be verified. This action will also involve the nozzle oscillating on the board surface while maintaining a following state. During the oscillation, please observe whether the nozzle moves over a large range (>10mm). You can turn on the red light to assist in the observation by observing the movement of the light spot on the board surface.

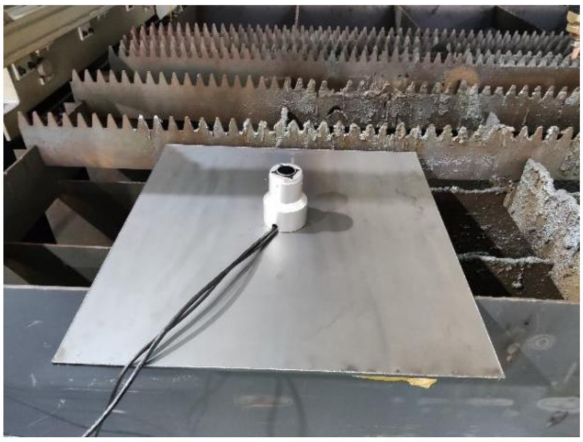


If there is no significant movement, the initial values are correct. Click "Raise Vertical" to return the cutting head to a vertical position. Otherwise, please check the configuration of each axis, including pulse equivalent and direction of movement.

2) Hardware connection

The final result should be as shown in the image below: the camera cable runs from the side of the base, the base can be placed stably on the board, and the filter can be placed stably on the camera lens.





The two cameras shown in the left and right images differ only in their housing design; their actual usage is the same. It's important to note that because the cutting head swings at a large angle during vision calibration, sufficient travel is required along the X, Y, and Z axes. This can be addressed by removing the rack and placing the sheet metal and camera directly on the machine bed to ensure sufficient travel along the Z axis.

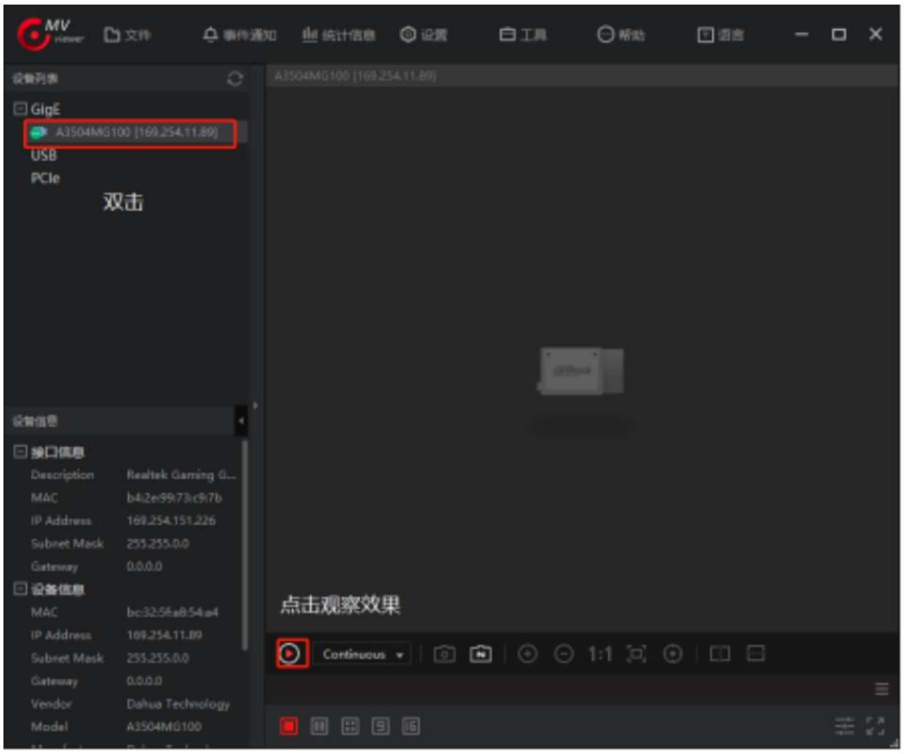
3) Prepare vision software

When installing **MV** Viewer (camera driver), please 

and **QBHVision** 

(Spot acquisition software, do not change the installation path.

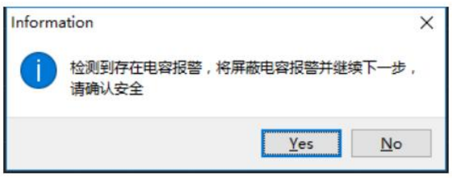
Upon initial connection, you need to run **MV Viewer** to connect to the camera and automatically configure the IP address. After successful configuration, this step can be skipped for subsequent visual calibration on the same machine.



After establishing the connection and verifying that everything is correct, close **MV Viewer** to prevent the camera from being occupied.

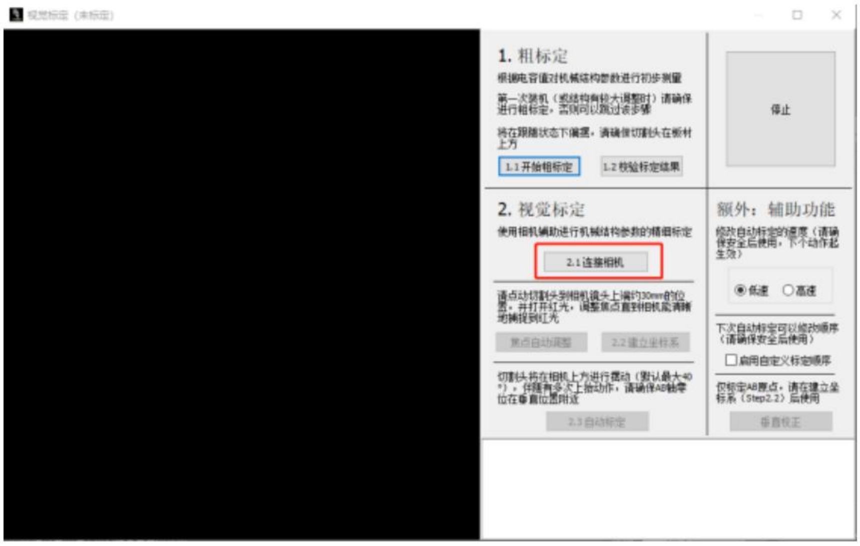
4) Visual calibration

Before performing vision calibration, unscrew the nozzle and ensure that **the AB** axis is vertical (mechanical coordinates are 0). Before entering the vision calibration page in this state, a prompt as shown in the image will appear. After confirming it is safe, click <Yes>.



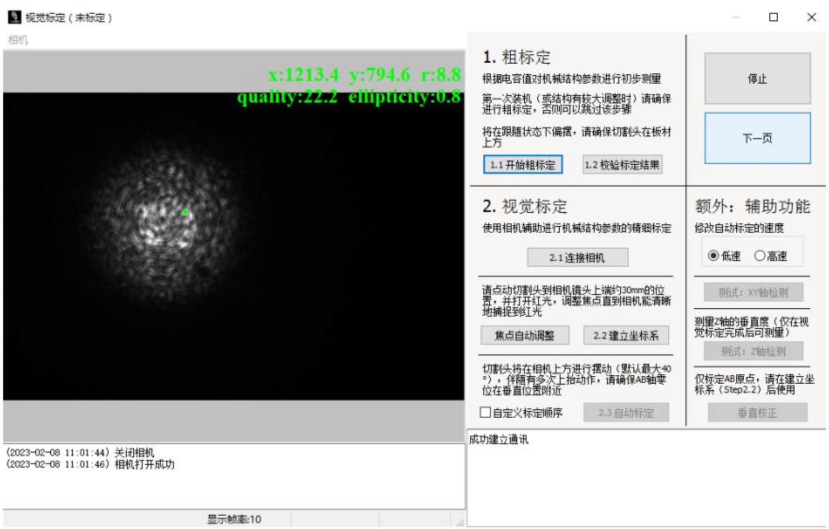
After configuring the IP , click <Connect Camera> in the vision calibration window, as shown in the figure below. If the spot detection software is installed in the default path, it will open automatically; otherwise, you need to select the QBHVision location in the pop-up file browser.

QBHVision will automatically attempt to open the camera after it is turned on. If it fails to open automatically, you can try to open it manually in the left menu bar.



Hold the cutting head 25mm above the camera, turn on the red light, move the camera so that the light spot is roughly in the center of the screen, and cover the lens with a filter, as shown in the figure.

By slowly adjusting the Z-axis height, a visible light spot appears within the camera's field of view, as shown in the figure.

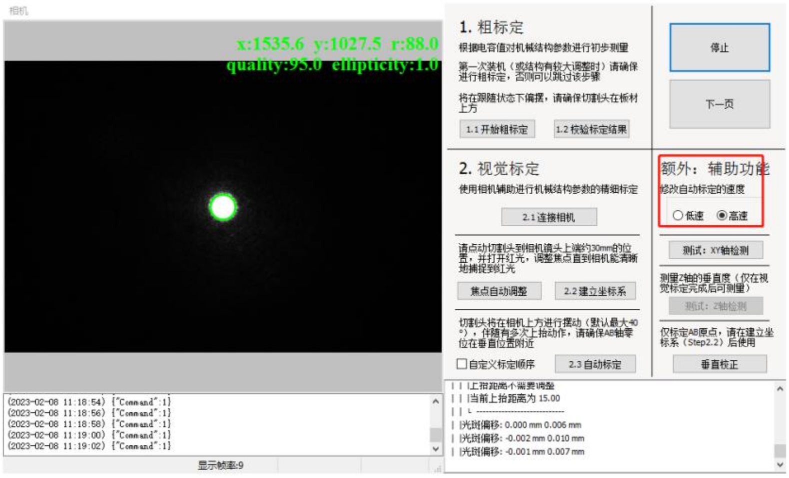


Click on <Auto Focus> to execute the automatic focus adjustment process.

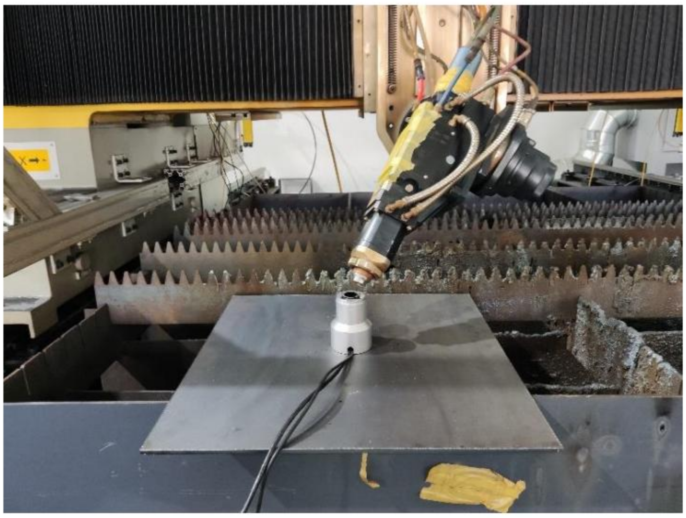
After adjustment, the light spot quality should reach 85 or higher, and the focal radius (r) should normally be within 100. If the adjusted light spot quality still does not meet the requirements, it is recommended to adjust the cutting head height appropriately or manually change the focal spot.

After adjusting the focus spot, click <Establish Coordinate System> to correct the positional relationship between the camera and the machine tool. Note: Under this command, the machine tool's X and Y axes will move back and forth multiple times, which may cause the spot to move out of the field of view, but it will normally find its way back into the field of view. After the coordinate system is established, the spot will be in the center of the camera's field of view, as shown in the figure.

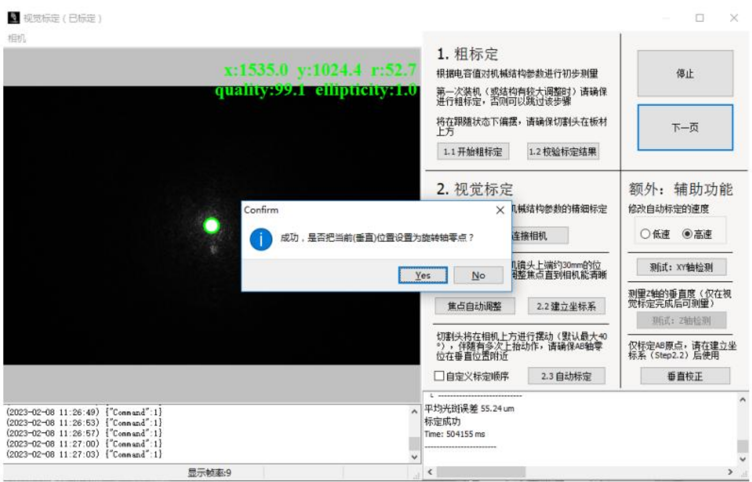
Automatic calibration will begin. Once the light spot is within the field of view, click "Automatic Calibration." This process will take approximately 5-10 minutes and will stop upon completion. It is recommended to set the automatic calibration speed to "High Speed" to improve calibration efficiency.



During the automatic calibration process, the cutting head will swing at different angles (from small to large: 1°, 4°, 8°, 16°, 30°, 40°). The operator needs to observe the position of the cutting head. If it gets too close to the camera, the operator should click the stop button at any time to prevent damage to the camera. At the same time, the cutting head will swing up and down along the Z-axis multiple times, but the lowest position will not be lower than the starting calibration position.

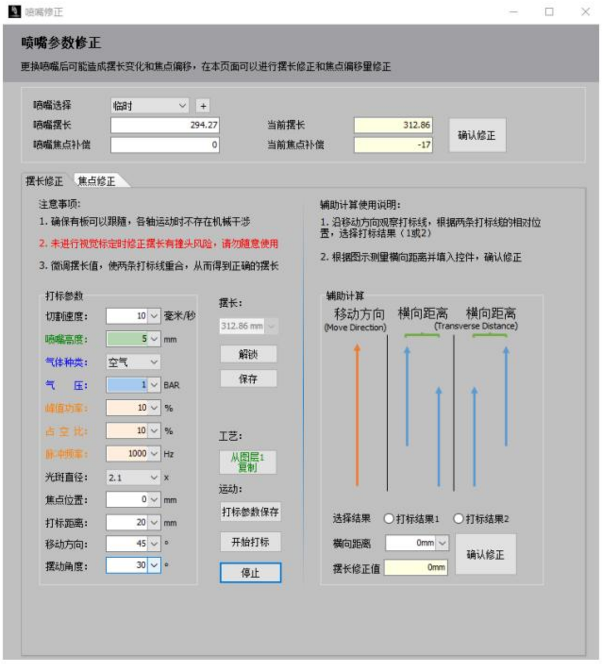


After successful calibration, click "Confirm" in the dialog box and set the AB axis zero point. The average spot error displayed in the lower right corner of the interface when calibration is successful should generally not exceed 7~8 micrometers (70~80ÿm). If the average spot error is too large, it is recommended to check for obvious errors in the mechanical assembly process.



5) Pendulum length correction

Open Tools - Nozzle Parameter Adjustment Tool, and enter the swing length correction interface.



Parameter settings: Cutting speed, gas, laser, and focal spot can be set according to normal marking parameters.

The nozzle height should not be less than 5mm (pure interpolation oscillation process does not produce light and has a low speed, posing a risk of collision with the plate). Marking distance is the length of the marking line segment, movement direction is the angle between the marking line segment and the positive X-axis (0 degrees represents the positive X-axis, 90 degrees represents the positive Y-axis), and oscillation angle represents the slope of the two marking lines (the larger the oscillation angle, the higher the accuracy of the oscillation length correction, with a maximum of 45 degrees. It is recommended to set the oscillation angle above 30°).

Click <Start Marking>, and the machine will mark two straight lines starting from the current position. Generally, the two lines should be parallel (if they are not parallel, it may be due to a deviation in the visual calibration result, requiring hardware inspection). Observe the relative positions of the marked line segments along the movement direction. Select either Marking Result 1 or Marking Result 2 according to the actual situation. Use calipers to measure the distance between the two line segments and enter the <Horizontal Distance>. At this point, the pendulum length correction value will be automatically calculated. Click <Confirm Correction>, and the pendulum length correction value will be added to the pendulum length parameters and written to the bottom layer.

After correction, it is recommended to mark it again to verify the correction result. If the two marked line segments overlap, it means that the current pendulum length is correct.